

### ABSTRACT OF THE DISCLOSURE

385 A modular, compact and widely tunable laser system for the efficient  
generation of high peak and high average power ultrashort pulses. Modularity  
is ensured by the implementation of interchangeable amplifier components.  
System compactness is ensured by employing efficient fiber amplifiers,  
directly or indirectly pumped by diode lasers. Peak power handling capability 51  
390 of the fiber amplifiers is expanded by using optimized pulse shapes, as well as  
dispersively broadened pulses. Dispersive broadening is introduced by  
dispersive pulse stretching in the presence of self-phase modulation and gain,  
resulting in the formation of high-power parabolic pulses. In addition,  
dispersive broadening is also introduced by simple fiber delay lines or chirped 108  
395 fiber gratings, resulting in a further increase of the energy handling ability of  
the fiber amplifiers. The phase of the pulses in the dispersive delay line is  
controlled to quartic order by the use of fibers with varying amounts of  
waveguide dispersion or by controlling the chirp of the fiber gratings. After 160  
amplification, the dispersively stretched pulses can be re-compressed to nearly  
400 their bandwidth limit by the implementation of another set of dispersive delay  
lines. To ensure a wide tunability of the whole system, Raman-shifting of the  
compact sources of ultrashort pulses in conjunction with frequency-conversion 207  
in nonlinear optical crystals can be implemented, or an Anti-Stokes fiber in  
conjunction with fiber amplifiers and Raman-shifters are used. A particularly  
405 compact implementation of the whole system uses fiber oscillators in  
conjunction with fiber amplifiers. Additionally, long, distributed, positive 249  
dispersion optical amplifiers are used to improve transmission characteristics  
of an optical communication system. Finally, an optical communication  
system utilizes a Raman amplifier fiber pumped by a train of Raman-shifted,  
410 wavelength-tunable pump pulses, to thereby amplify an optical signal which  
counterpropagates within the Raman amplifier fiber with respect to the pump  
pulses. 303